A climate and socio-economic study of a multi-member state carbon price floor for the power sector

Executive summary

20 December 2018

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Content

Study context and FTI-CL Energy mandate

- **The European Commission has reaffirmed and increased its commitment to decarbonise its economy** with the ratification of the Paris agreement on 5 October 2016
- **The power sector has a key role to play in the decarbonisation of the European economy**:
  - An efficient and sustainable transition would avoid lock-in in thermal plants, …
  - and facilitate investment in capital intensive low carbon technologies.
- **With this background in mind, FTI-CL Energy has been mandated by a group of sponsor companies to:**
  - Assess the EU ETS price outlook and resulting progress against EU objectives; and
  - Identify the possible contribution of a CPF to an accelerated decarbonisation of the power sector.
  - Using fact-based modelling, and assumptions based on third parties recognized independent studies.

Study committee members

Eneco, Siemens Gamesa, EDF, Ørsted, edp, Iberdrola, Vestas, Shell, Engie, EnBW

Strong and credible economic signals are needed to support a rapid decarbonisation in line with the Paris Agreement

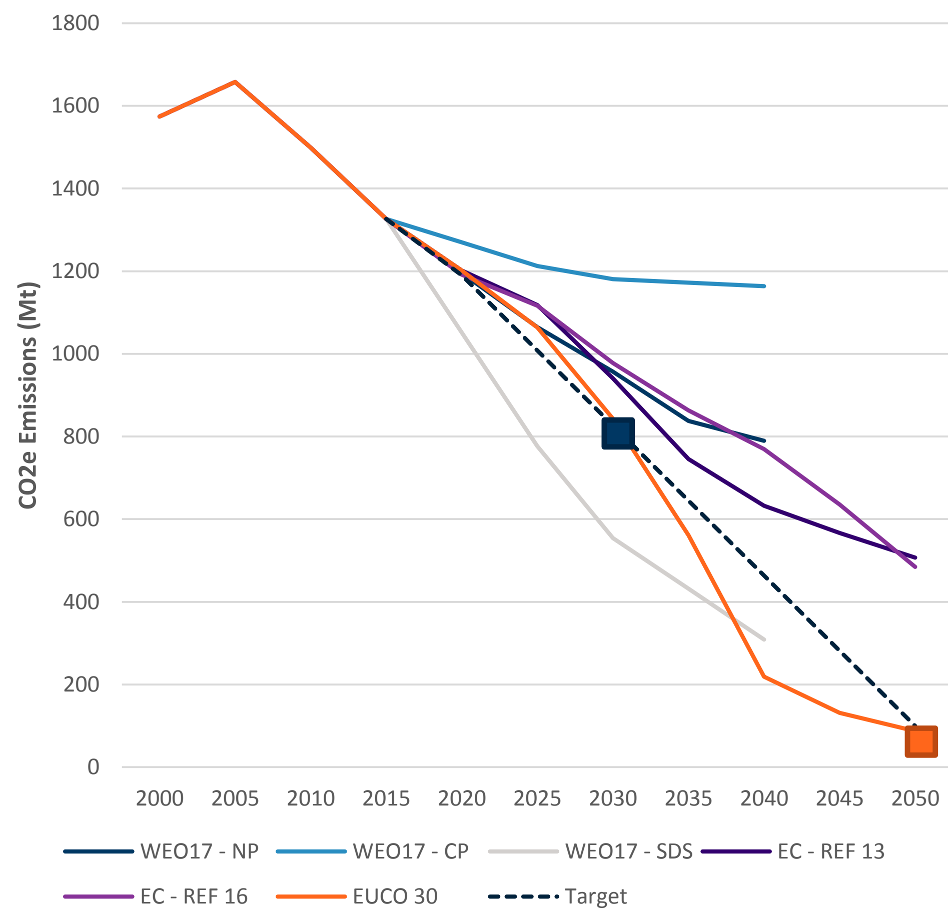
Challenges for policymakers and investors

- Global action consistent with the **Paris Agreement and 2C** may require more than 40% emissions reduction from the EU by 2030, and net zero emissions or more by 2050
- The **power sector** is central to the decarbonisation of the European economy

An efficient energy transition requires clearer and more predictable price signals

- Major **investment and retirement** decisions in clean technologies are required to decarbonize the power sector
- The EU ETS price is **insufficient in the short term**, and does not provide a **strong and credible enough signal** for decarbonisation in the medium to long term

EU CO2e Emissions and targets to 2050



2030 Targets: GHG 40% (826Mt), RE 32% of energy and RE in Power 57%(modelled)

2050 Targets: GHG 80-95% (100Mt)

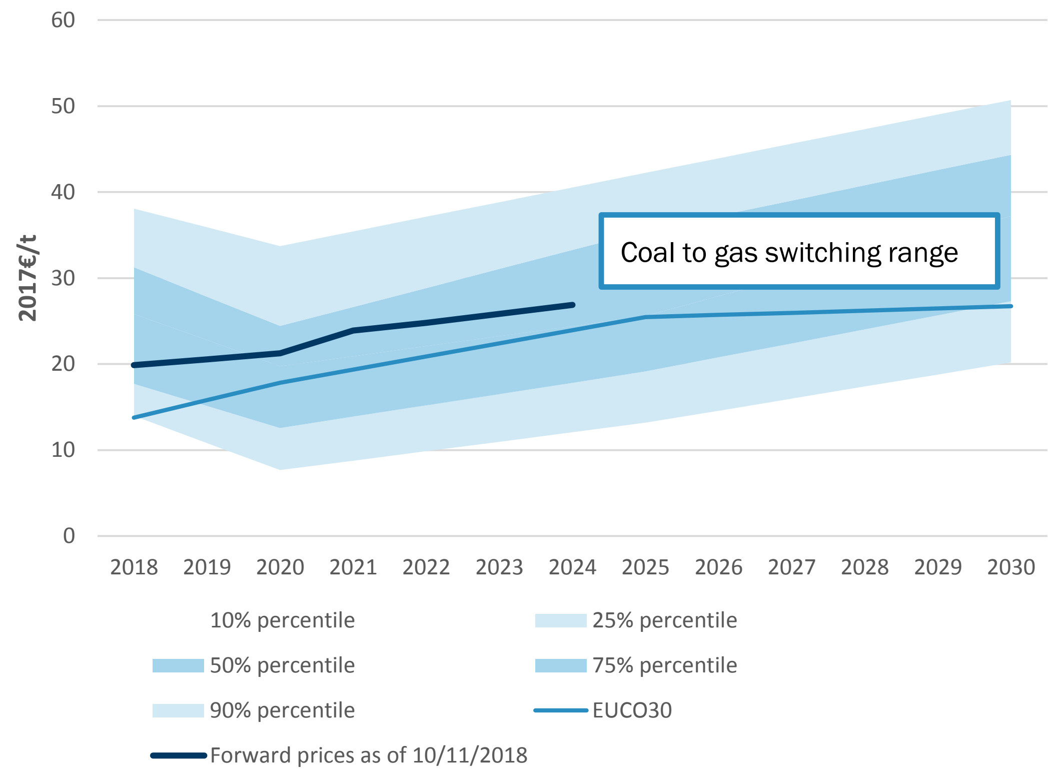
Source: International Energy Agency, European Commission

ETS prices are insufficient in the short term to drive the decarbonisation of the EU power sector

ETS reform is helping but not enough

- Current prices around €20/t are due to the **ETS reforms**, market fundamentals, and hedging behaviour.
- However **parallel policies** such as energy efficiency, RES support, nuclear support, coal phase outs reduce the prospects for a sufficient carbon price.
- **Sustained coal and lignite to gas switching** across Europe would require prices around €15-35/t in the near term, but in the 2020s would require around €20-50/t according to our analysis.
- Current **forward prices are too low** to:
  - Drive a full switching between coal and gas units
  - Incentivize large scale renewables to be developed on a merchant basis

EU ETS carbon price pathways (real 2017)



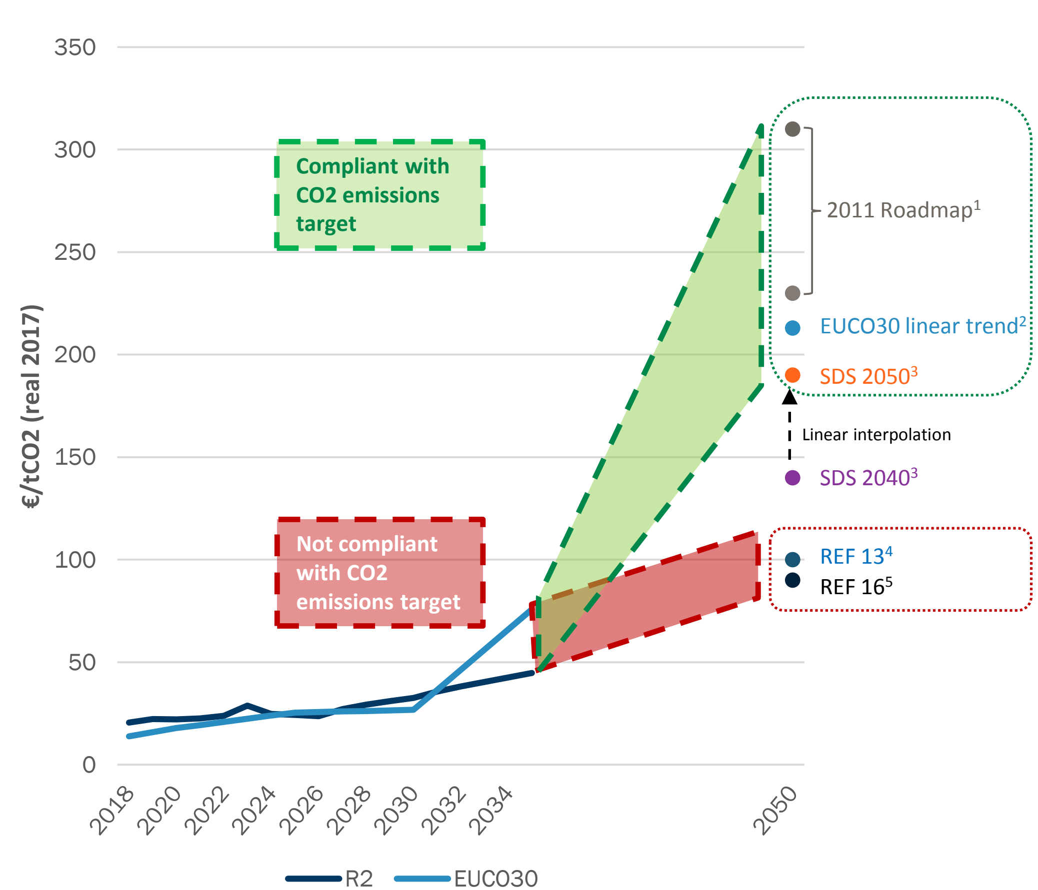
Source: EEX, European Commission

Long term carbon prices may need to rise significantly to complete decarbonisation of some sectors

ETS prices are not intertemporally efficient

- In the long run, **carbon prices may need to reach between 130-150 €/t from 2040** based on Commission and IEA modelling to drive a full decarbonisation of the EU economy
- Such estimates raise the issue of the ETS's ability to send **long term predictable and credible price signals** to investors.
- Too low and unclear price signals in the medium term could lead to:
  - **Technology lock-in for fossil fuel technologies** and the risk of stranded assets
  - **Inefficient investment signals in renewables and low carbon technologies**

Long term EU carbon price (real 2017)



Source: FTI CL Energy modelling, European Commission (EC), International Energy Agency (IEA)

[1] 2011 EC Roadmap to 2050

[2] EC scenario to achieve the 2030 energy and climate targets, interpolated from 2030-2035

[3] IEA Sustainable Development Scenario, 2050 figure interpolated from 2040 figure

[4] 2013 EC Reference scenario

[5] 2016 EC Reference scenario

Carbon price risks affect investment decisions

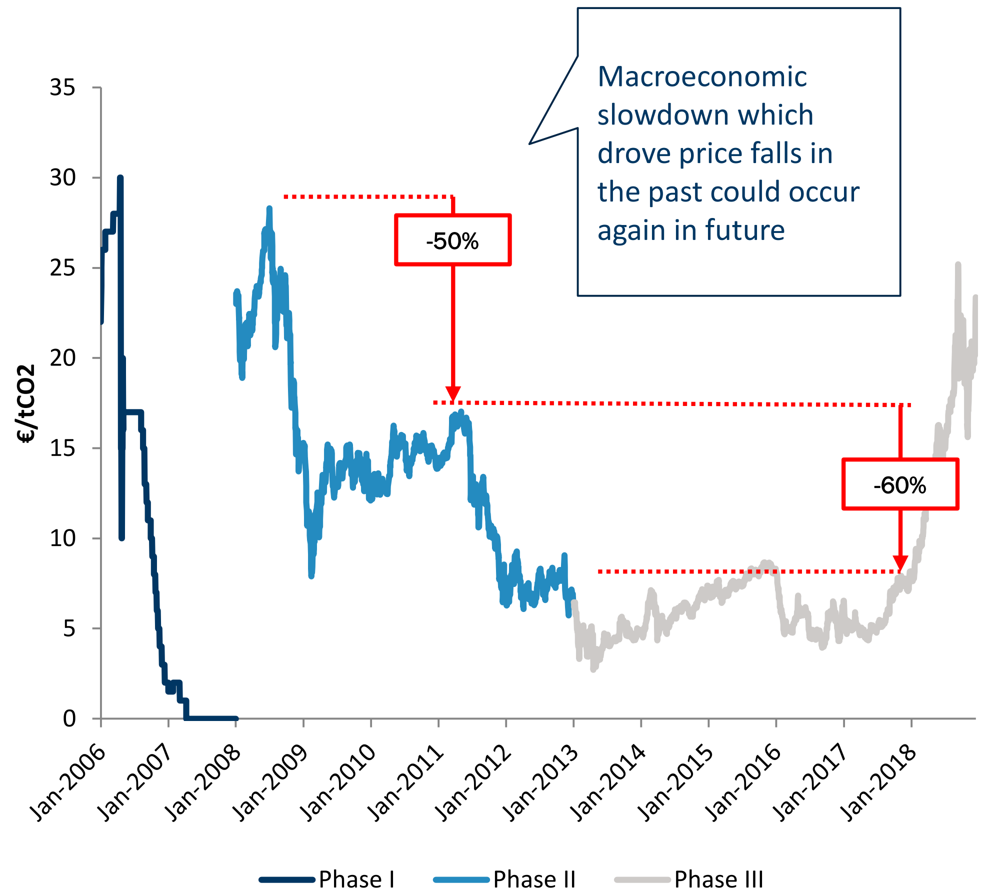
Investors in clean technologies see falling technology costs, but increasing market risk

- **Technology costs** are coming down, improving the business case for renewables investment
- But **revenues are increasingly uncertain as** greater reliance on power prices (and carbon prices as they affect power prices) **increases investor risk**

Investors focus on the *expected* carbon price and the risk that the price in the future may be lower than anticipated

- **Anticipated carbon prices** included in investors' business plans include a significant discount compared to base case projections reflecting the risk of a future price shock / decrease
- It is efficient for Governments to **protect investors against policy risk** which markets cannot accurately price

ETS prices 2006-2018, a history of price falls (downside risk)



… at a time when most competitive renewables are increasingly bearing market risk

Renewable projects and the "merit order effect"

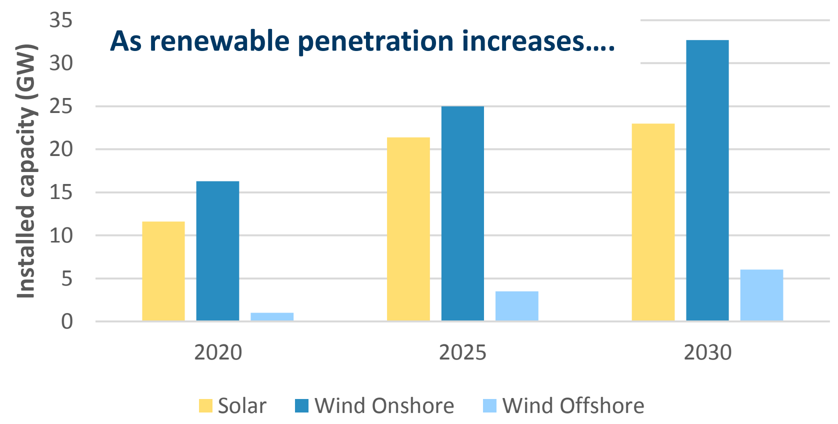
- Renewables are **low marginal cost** – they push out fossil generation from the merit order
  - **Wholesale prices fall** as a results of increased renewables penetration

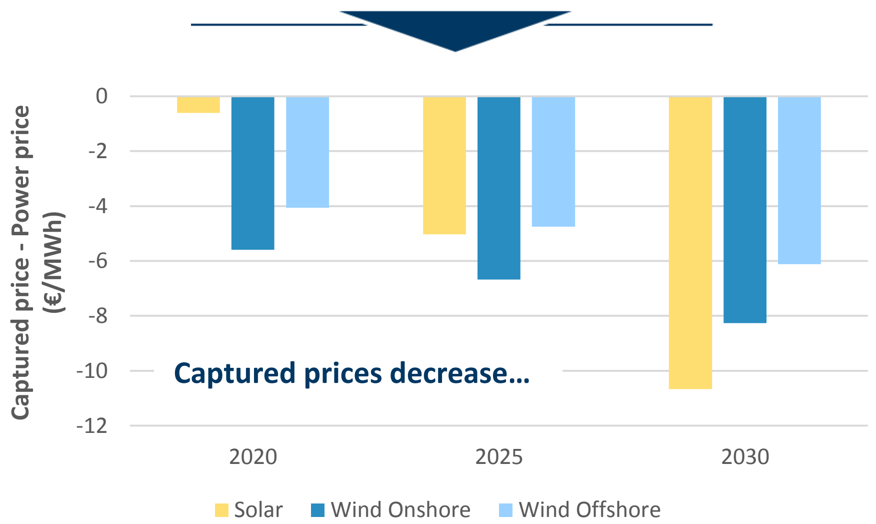
- But investors see a **correlated revenue risk** (referred to as 'cannibalisation of revenues')
  - The **captured prices** by wind and solar projects refers to the price achieved during half-hours when wind and solar are generating

- **Carbon price risk** amplifies power price risk and is driven by hard to predict policy decisions
  - The effect on wind and solar revenues will **become worse over time** as renewables penetration increases
  - Additional **storage and other forms of flexibility** on the system would act to smooth out prices

Merit order effect and RES Captured prices

(France to 2030)





High carbon and electricity price risks lead to higher cost of capital and financing constraints

Higher risk increases cost of capital, and constrains access to finance

- Renewable energy projects currently enjoy low cost of capital and access to a wide range of investors due to being considered quasi regulated assets with low risk profiles
- **Greater exposure to power price risk** would
  - Increase the risk premium
  - Reduce debt levels
  - Reduce the pool of investors

We have gathered evidence on the size of the impact

- **Literature review/benchmarking** suggests that power price risk could add around **3-5% points at least onto the WACC for power plant investments**.
- **Financial sector interviews** have broadly supported this range, and further stressed the diversity of financial investors, with very **different tolerance for risk**.
- Our analysis, literature review and interviews suggested that a **CPF could reduce the risk premium** by around 1% point

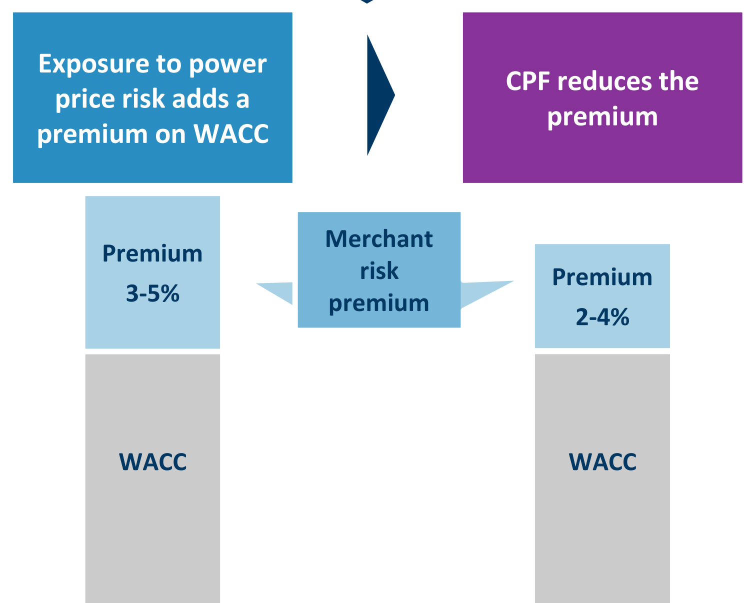
Price risk (power, carbon) increases financing costs

Literature review/benchmarking

- The impact of risks in renewable energy investments and the role of smart policies — **Diacore (2016)**
- Changes in hurdle rates for low carbon generation technologies […] — **NERA (2013)**
- Can German renewables become competitive within 5 years — **Aurora (2013)**
- Towards triple A policies: more renewable energy at lower cost — **EU research project Re-Shaping (2011)**
- Note on impacts of the CfD […] on costs and availability of capital and discount on PPAs — **CEPA (2011)**

Financial Sector interviews

BNP PARIBAS, CRÉDIT AGRICOLE, HSBC, MUFG



What could be the impact of a Carbon Price Floor (CPF)?

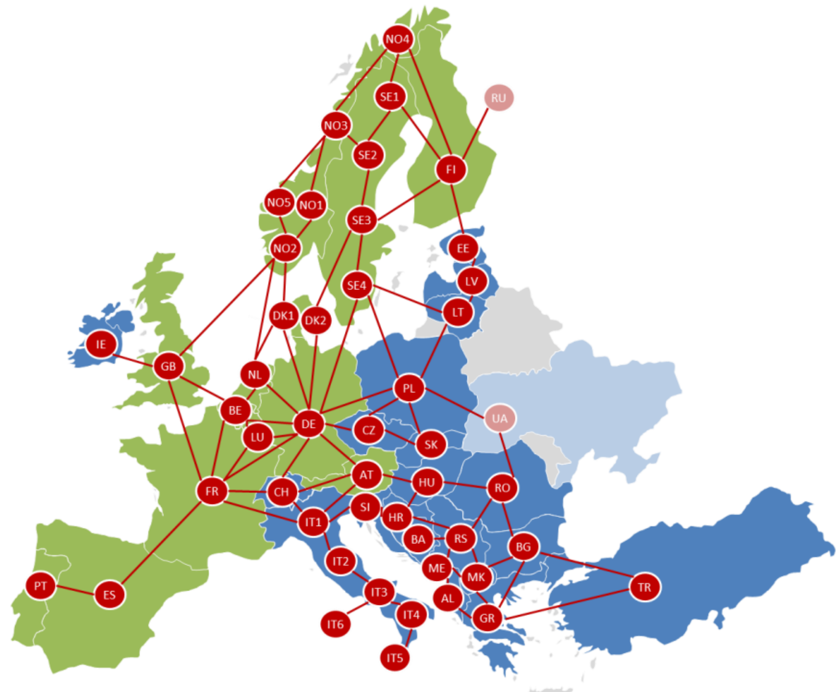
- A **Carbon Price Floor (CPF)** is a mechanism that Governments can use to create a minimum carbon price in their countries.

- **Different implementation models could be used :***
  - As a **top up tax** on the power sector above the EU ETS price (the UK model)
  - **Permit buy backs** – the Government or a market operator could commit to buying EUAs at a minimum price
  - As an **auction reserve price** – e.g. the Government could hold back permits from auction if the price went below a certain level

- In this study **we have not considered implementation questions**, but have assumed that the CPF is implemented in a way which is credible to the market and investors in a '**coalition of the willing' grouping 12 EU member states – in order to minimise unintended consequences such as carbon leakage**.

- In this study, we assume that:
  - The CPF is implemented in **12 Member States as a top up tax**
  - The CPF only impacts the **power sector**
  - **The MSR** will absorb some of the surplus allowances generated by the CPF - **Complementary policies** (such as EUA cancellations) are introduced and absorb the rest in order to maintain the effectiveness of the ETS and minimise leakage to the non-CPF Zone.

We have modelled a CPF introduced in 12 EU member states (the UK is assumed to keep its CPF)



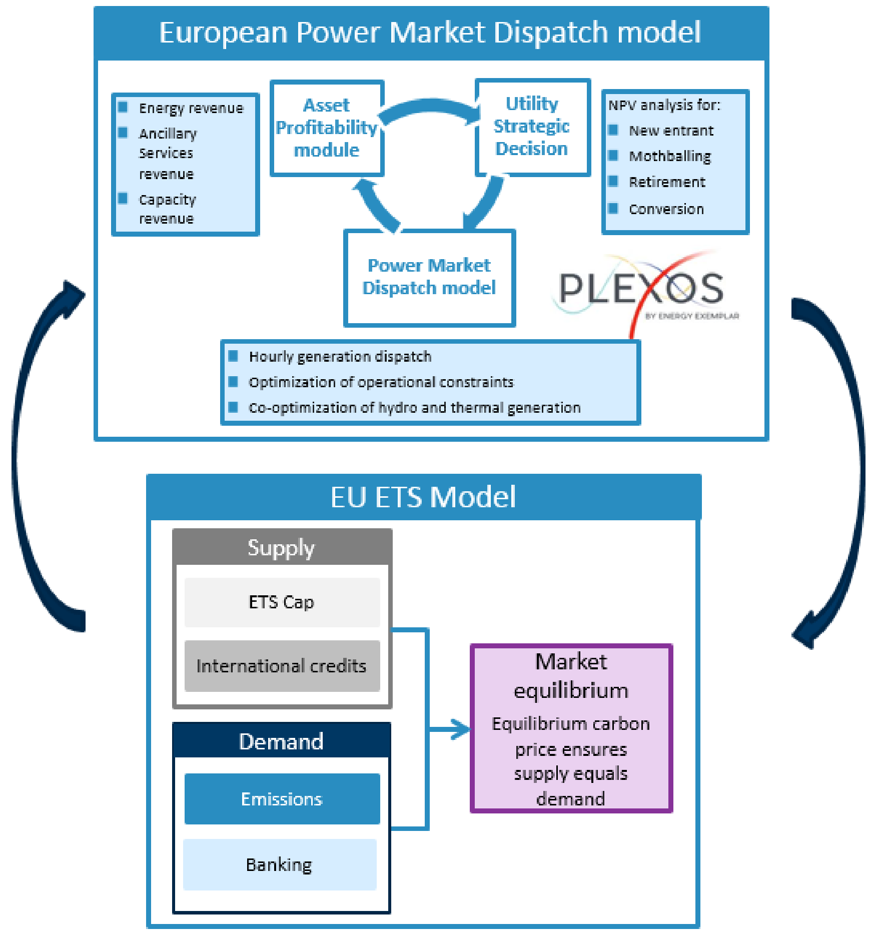
CPF Countries: Germany, Austria, France, Spain, Portugal, Belgium, Netherlands, Luxembourg, UK, Denmark, Sweden, Norway and Finland.

- *Newbery et al (2018): When is a carbon price floor desirable? , EPRG Working Paper – Note permit buy backs would only work at EU level*
- *There is also another option whereby regulation would require companies within the CPF zone to surrender additional allowances*

Modelling Approach: Combination of ETS and EU Power Sector Models, based on authoritative and public assumptions

- **FTI-CL's modelling approach is based on:**
  - FTI-CL Energy's in-house European power market model and EU ETS model , grounded in reputable modelling platform; and
  - Background assumptions based on third party studies compatible with EU objective of (i) energy consumption reduction and (ii) decarbonisation of the EU wide economy.
- **A two-step optimisation process is performed by our power market model:**
  - **Dynamic optimisation of the generation mix** based on the economics of RES, thermal plants and storage, to ensure security of supply and meet EC objectives at the least cost; and
  - **Short term optimisation of dispatch** of the different units on a hourly basis.
- **This study has used our proprietary models to investigate:**
  - The ETS price outlook and resulting progress against EU objectives
  - The possible contribution of a CPF to an efficient decarbonisation of the power sector

We have used our EU power market model and our EU ETS model



To assess the potential role of a CPF, we have modelled a range of scenarios

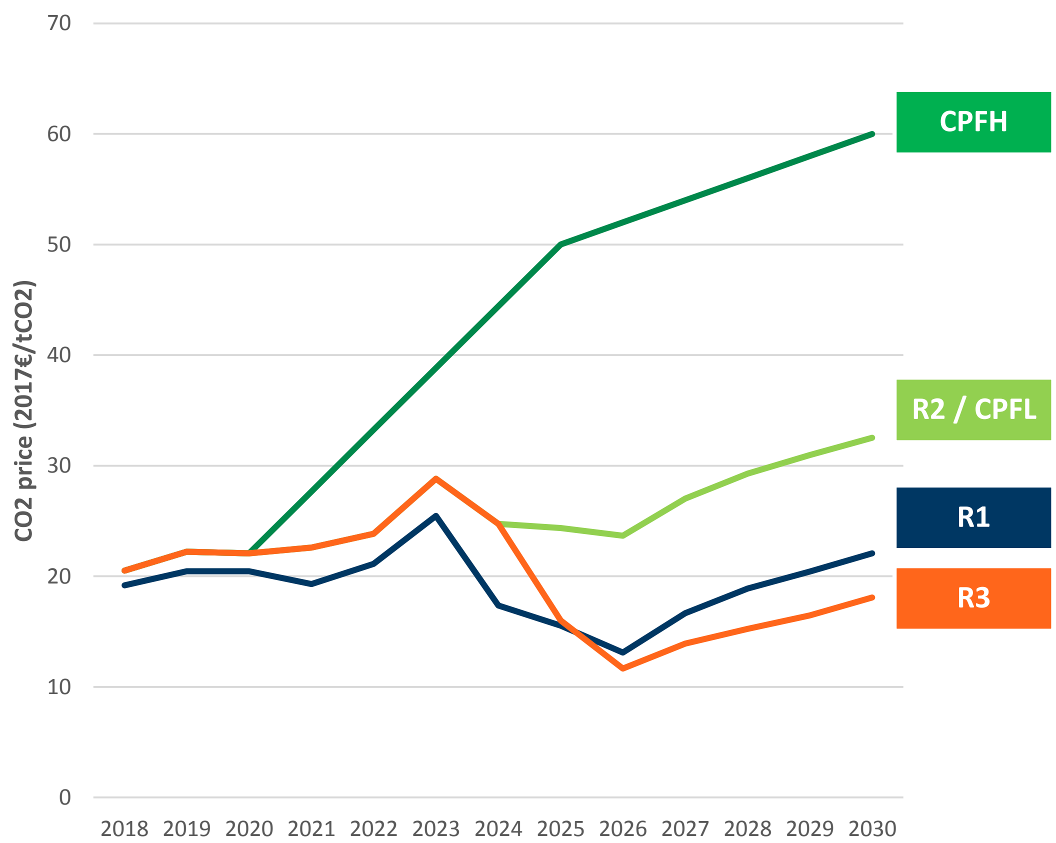
Contrast Scenarios

- **R1 scenario (ETS Low):** ETS prices remain low on the basis of current parallel national RES policies
- **R2 scenario (ETS High):** ETS prices are higher as a result of phasing out parallel RES policies and RES being more exposed to merchant price risk
- **R3 scenario (ETS Price Fall)** illustrates the plausible impact of a demand reduction on ETS prices (based on analysis of historical precedent)

Carbon Price Floor Scenarios

- **Carbon Price Floor High (CPFH)** sets the **CPF at €20/t in 2020 rising to €60/t in 2030.** This scenario illustrates a higher ambition world in which policymakers want to put a major policy emphasis on the carbon price instrument to meet their national RES objectives. The ETS price in the Non-CPF zone is assumed to be kept at the R2 level
- **Carbon Price Floor Low (CPFL)** sets the **CPF at €20/t rising to €30/t in 2030.** This illustrates the role the CPF can play even when set at a similar level to the expected ETS price, as an **insurance policy** against sudden ETS price falls. The ETS price in the Non-CPF Zone is assumed also to be kept at the R2 level

Carbon Price Scenarios to 2030



Note: (1) CPFH RES new capacities are set at R1 RES new capacities to meet national RES objective in CPF countries. (2) R2, R3 and CPFL RES new capacities are built based on a least cost capacity mix expansion optimization.

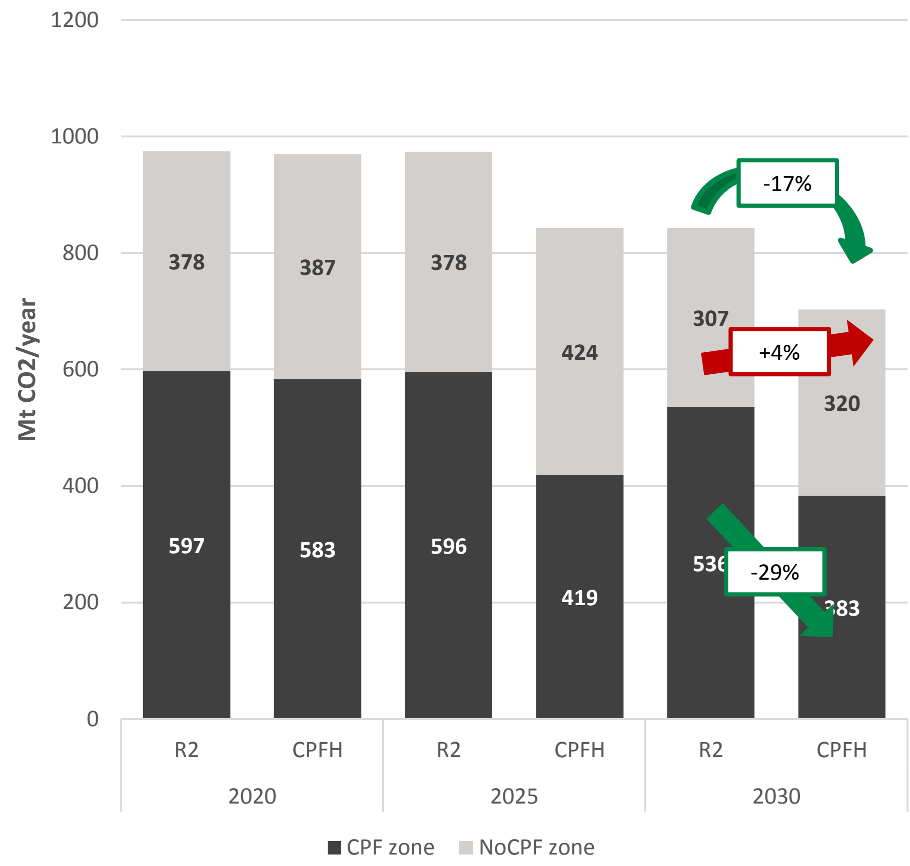
A Carbon Price Floor (CPF) could reduce emissions at the EU Level

Power sector decarbonisation could be accelerated

- A CPF would **reduce emissions overall across Europe**
  - In the CPF High scenario **power sector emissions in the CPF Zone are 29% lower, and 22% lower cumulatively** between 2020-2030 compared to the R2 scenario
  - **ETS emissions in 2030 are 17% lower** and 11% lower in cumulative terms
  - The CPF Low scenario shows that emissions reductions are possible without a higher carbon price – if investors believe in a credible carbon price, more investment in renewables will replace fossil generation faster and reduce emissions compared to R2

- **Emissions leakage** through cross-border flows can occur to the extent that CPF abatement leads to surplus ETS allowances and price falls in the ETS.
  - The MSR will however absorb some of the surplus.
  - The leakage can be further **minimised by ETS complementary policy** to cancel excess allowances (reducing the price differential between CPF and non-CPF zones), and through ensuring that the **CPF zone is of a minimum acceptable size**

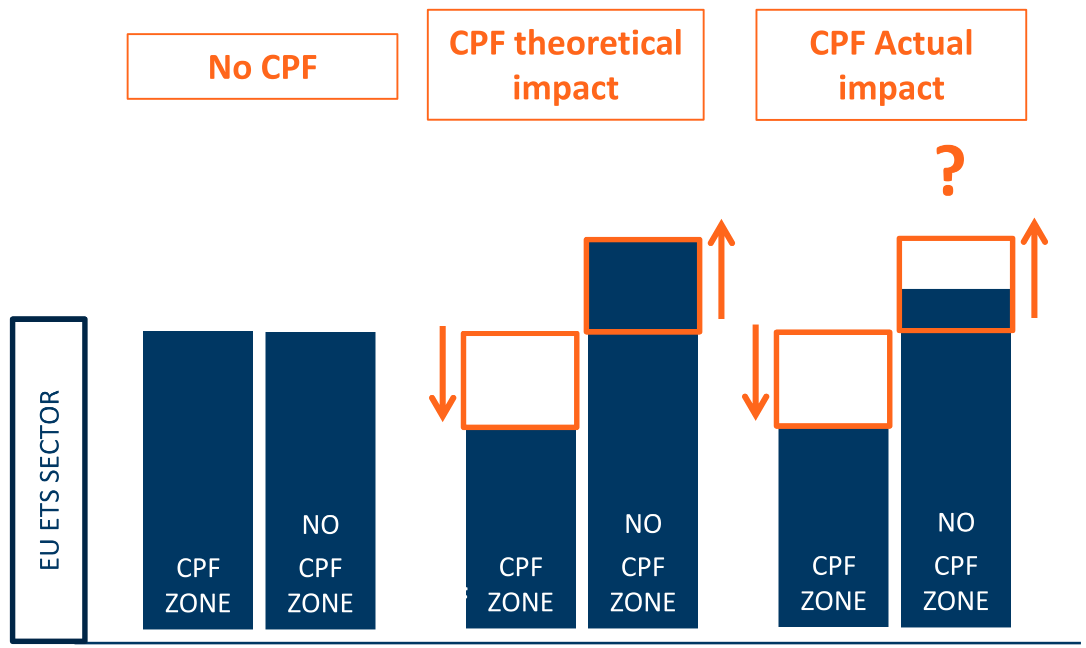
EU ETS Power Sector Emissions (MtCO2e/year)



The CPF and the ETS: current reforms may not be sufficient, but cancellations or continued reform can preserve emissions reductions

- The **introduction of a CPF** would need to be managed carefully to protect the EU wide carbon (ETS) price
- The **theoretical impact** of a CPF would be to reduce demand for EUAs as CPF induced abatement in the CPF zone. Within the overall EU wide cap this could lead to a surplus of EUAs and falling ETS prices.
- **In theory the MSR could absorb the surplus supply relative to demand, but is unlikely to do so in its current definition**
- **In practice** demand and prices especially in the industrial sectors (33% of total EUA demand) may be "sticky"
- We have taken a **conservative approach** in our modelling assuming that the theoretical impact prevails and therefore complementary policies would be required to underpin the EU wide ETS price (e.g. cancellation of allowances or continued ETS reform such as the MSR intake rate increased to 48% of surplus, or linear reduction factor increased).
- However, the adjustment of industrial output may be lower or slower meaning that the **complementary policies may not be needed as quickly or to the same extent**

Emissions in 2030 with CPF implementation



A Carbon Price Floor (CPF) could accelerate coal to gas switching and coal retirements

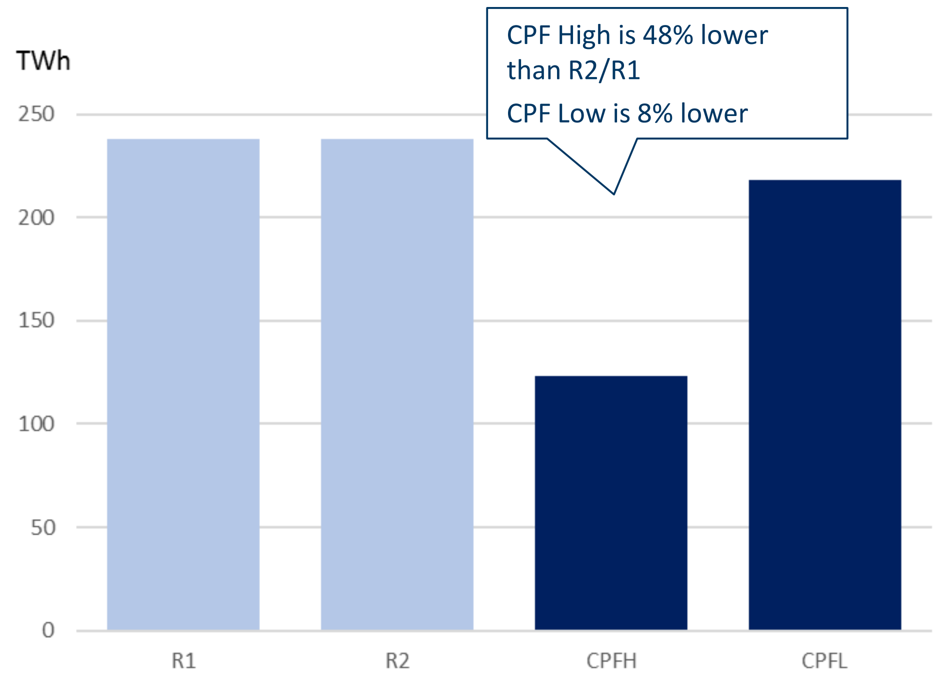
Coal is phased out faster

- A CPF would **reduce the amount of coal generation** as well as the installed coal capacity **significantly faster** than existing ETS price projections

- The **CPF makes coal less competitive** compared to gas and other lower carbon technologies, leading to lower coal plant load factors, and lower coal-fired generation
  - In 2030 in the **CPFH scenario** coal-fired electricity generation across the EU as a whole **is 48% lower** than in the R1 and R2 scenarios
  - In the **CPFL scenario** coal-fired electricity generation across the EU is **8% lower**

- This provides a clearer signal to coal plants to retire so installed capacity in 2030 is 8% lower in the CPFH scenario

EU 28 Coal Fired Generation – 2030*



*Notes: Coal and lignite generation

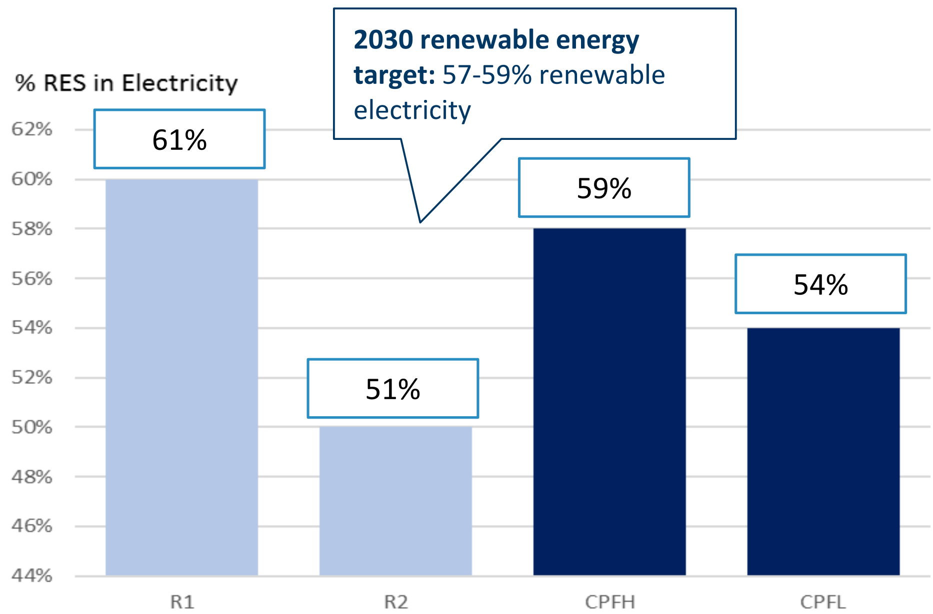
A Carbon Price Floor (CPF) could support renewables investment, in a more competitive merchant environment

Supporting renewable investment, by reducing risk and cost of capital

- The **R2 scenario** shows that the move to 'merchant RES' could reduce renewable investment considerably – without RES support schemes and exposed to power and carbon price risk, RES generation only reaches 51% of total electricity in 2030

- A **CPF would reduce carbon and power price risk and increase power prices in the short term (to 2025)**, and therefore support renewable projects development

Renewable energy* as % of Electricity production - 2030



* Notes: Renewable generation takes into account Wind, Solar, Hydro excluding PS and Other Res

The power price impacts depend on the fossil-fuel mix and merit order effects

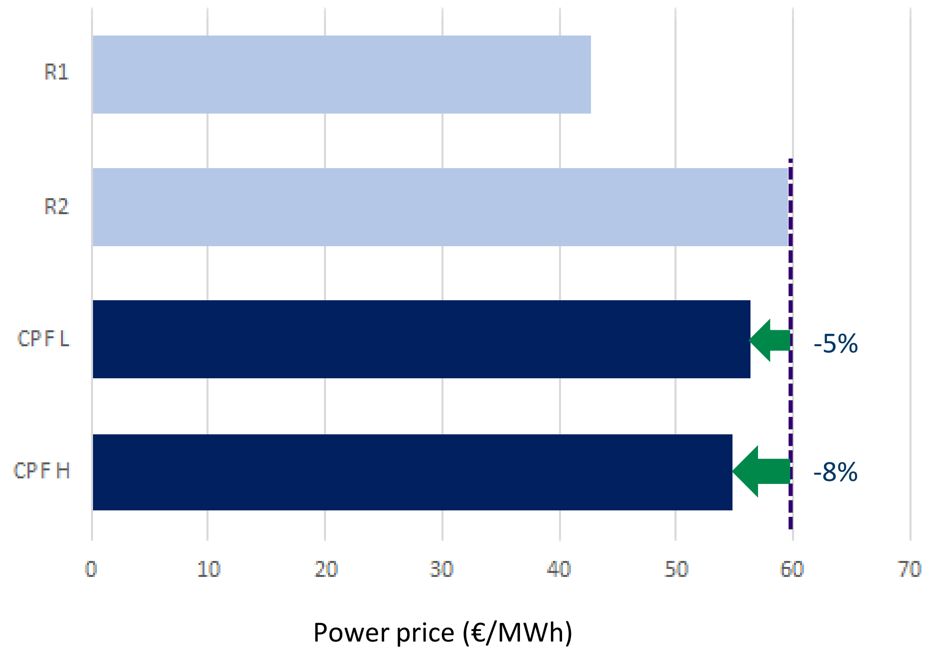
A tale of two effects

- A CPF would **increase wholesale power prices** (to 2025) to the extent that fossil fuel generators are setting the power price
  - In the medium to long term this effect will diminish as more low variable cost RES are added to the mix
  - As fossil fuel generators are taken off the system, the power price will be less influenced by the CO2 price

- A CPF would **decrease wholesale power prices** in the long term (post 2030) to the extent that it enables greater investment in renewable capacity and reduces the cost of capital
  - Our modelling suggests that by 2030 the overall impact of a CPF on power prices can be moderate and slightly reducing power prices when compared to the R2 scenario

- In the R1 scenario the power price is lower because part of the decarbonisation costs are paid through RES support schemes

EU Wholesale Power Price* - 2030



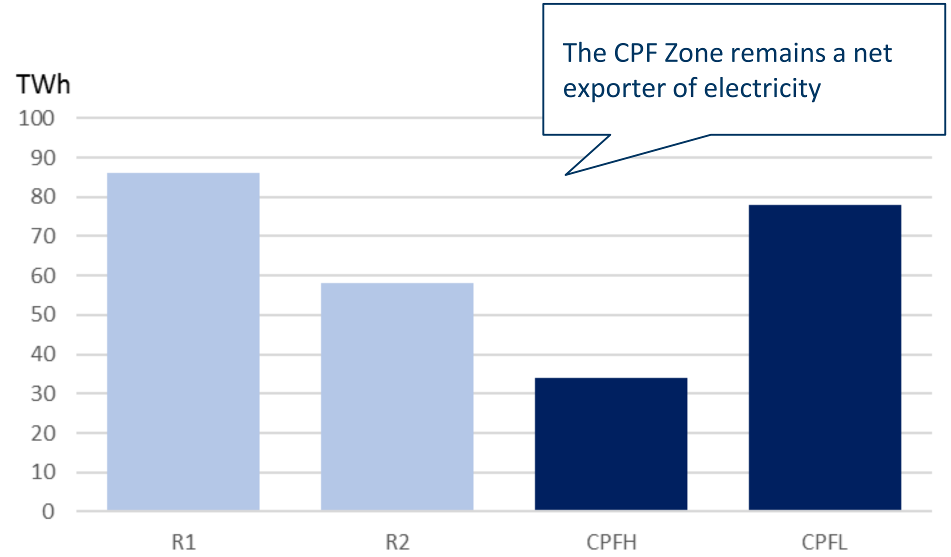
Notes: *Load weighted average power prices for all European countries

A CPF would affect net exports from the zone – a wider CPF zone would minimise these

Net exports will depend on power price differentials

- Cross border flows will in general be driven by price differentials
- Overall the **CPF Zone would continue to be a net exporter** of electricity to the non-CPF Zone
  - With a higher CPF the price differentials at key borders lead to a significant reduction in net exports
  - With a lower CPF the power prices at key borders lead to net exports virtually the same as in R1
- With **the higher CPF some countries can start to become net importers of power.**
  - However, this effect diminishes over time as greater renewables investment drives down prices through the merit order effect
- A **wider CPF Zone would minimise the impact on net exports**.
  - Conversely, a smaller zone (such as excluding Germany) would increase electricity and emissions leakage.

Net Electricity Exports from CPF Zone - 2030

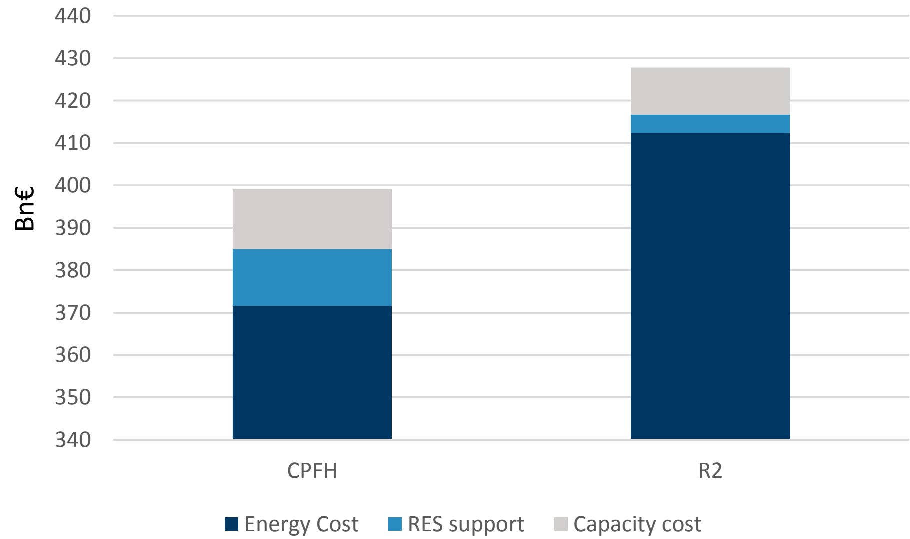


Socio-economic impacts from a CPF depend on power prices - lower investment costs and power prices would benefit consumers

Impacts on consumers

- The impact on consumers would **depend on wholesale power prices** – but **also on the effect on renewables support costs and additional capacity costs** to maintain security of supply.
- Lower power prices via the merit order effect could lead to lower consumer energy bills by 2030.
  - **In 2030 consumer costs are almost €30bn (6%) lower in CPFH than in R2**, wholesale energy costs are lower though partially offset by somewhat higher renewables support costs (under CfD/variable premium regimes the support cost goes up if power prices go down and vice versa). The increase in RE support costs is €9bn.
- Compared to **the R1 scenario** total energy system costs are €5bn higher (the CPF scenario has higher energy costs, but lower renewables support and capacity costs)

Net Impact on Consumer Costs in 2030 – CPFH versus R2



Source: FTI Power Price and ETS models; Technical report on Member State results of the EUCO policy scenarios, E3MLab & IIASA, December 2016

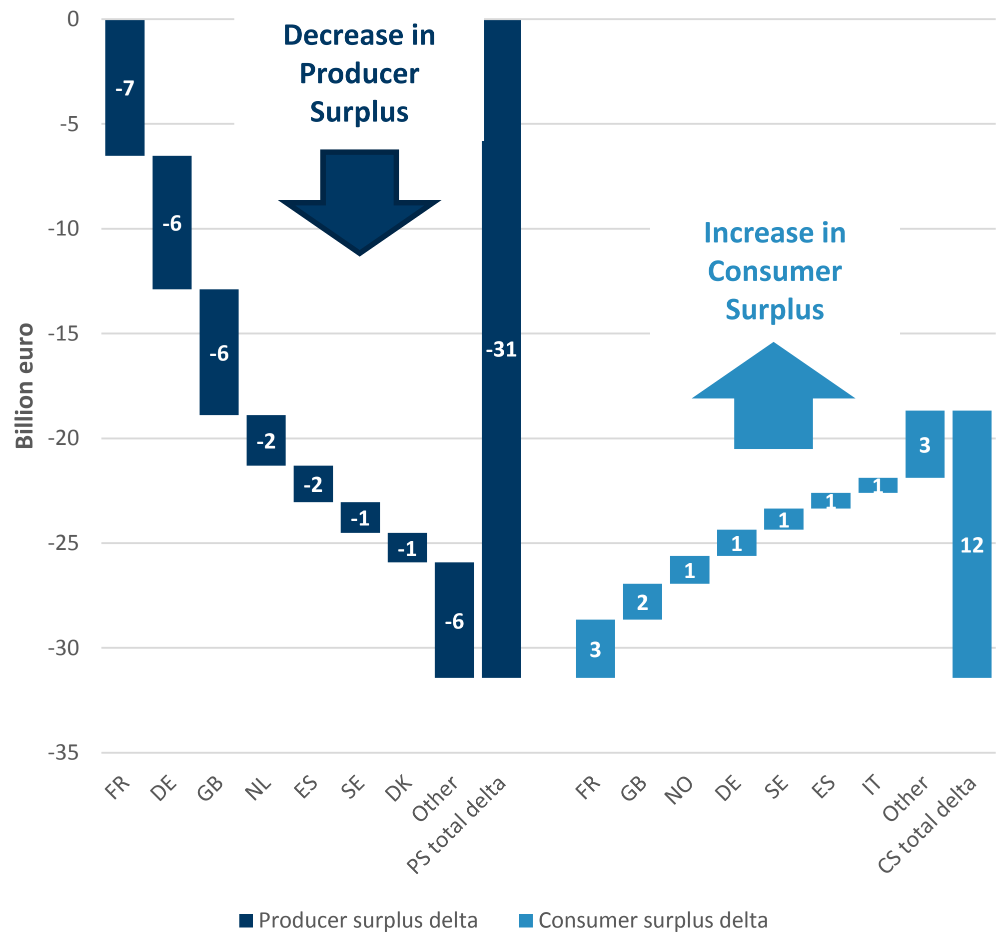
Notes: Power price paid may vary by sector; Domestic demand represents residential and tertiary demand. CPF Countries include Germany, Austria, France, Spain, Portugal, Belgium, Netherlands, Luxembourg, UK, Denmark, Sweden and Finland. Our analysis does not include electricity network costs or charges which could be affected.

Consumers would benefit from lower power prices, producers would see lower revenues

Socioeconomic impacts – consumers benefit

- Socioeconomic impacts were assessed by calculating the **consumer and producer surplus**
- Lower power prices in the CPFH scenario compared to R2 would lead to consumers paying less for power
- Capacity costs could rise in order to ensure security of supply, and the support costs for legacy renewable support schemes could also increase with lower power prices
- But the net effect is shown on the chart to the right – **a net saving for consumers** of €12bn in 2030
- The largest power producers (FR, DE) would face the largest falls in producer surplus
- The difference between the total amounts of producer and consumer surplus represent **revenues going to Government** (tax receipts from the CPF), to the **providers of capital for new investments in the power sector, and to interconnectors**

Producer and consumer surplus, CPF Zone 2030 (difference R2 to CPFH)



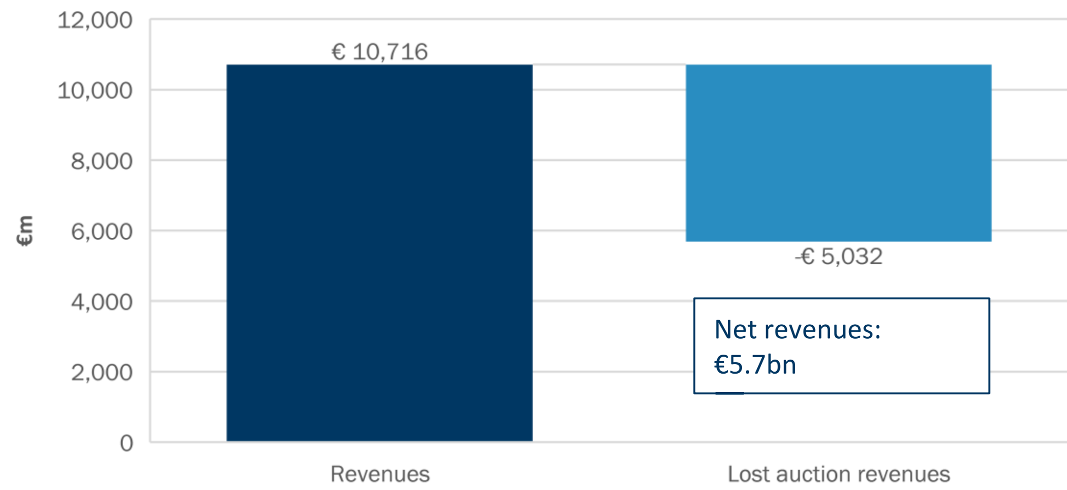
Impacts on Energy Intensive Industries will depend on power price impacts, and are manageable with additional carbon revenues

Impacts on Energy Intensive Industries (EII)

- Carbon leakage, as well as relocation of economic activity or investment to jurisdictions with lower carbon costs – is a concern for Energy Intensive Industries
- **Within the EU ETS,** some of these sectors are protected from such competitiveness impacts through free EUA allocation
- The **EU regulations** also allow for member states to **compensate Energy Intensive Industries** for other direct and indirect costs (electricity price)
- Our modelling suggests that the CPF could reduce power prices by 2030, leading to a net energy cost savings for **the Energy Intensive Industries** (a saving of €1.9bn in CPFH compared to R2)
- **Carbon revenues to Governments from a CPF** (net of the cost of the complementary policies i.e. lost auction revenues) would be over €5.7bn
  - Even comparing the CPFH scenario to R1, this revenue would be more than enough to compensate the higher energy costs of €4bn for Energy Intensives (power prices are higher in CPFH than in R1)

Carbon revenues and Energy Intensive Industry costs 2030

Government CPF Revenues - comparison of CPFH vs R2 scenario



CPFH net revenues: €5.7bn	>	**EII net costs vs R2:** -€1.9bn
CPFH net revenues: €5.7bn	>	**EII net costs vs R1:** €4bn

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Our study shows the limitations of the recent ETS reform and the potential benefits from a Carbon Price Floor (CPF)

Context: More ambitious decarbonisation is needed

- The European Commission has reaffirmed and increased its commitment to decarbonise the EU economy
- Power sector decarbonisation is key – and requires strong carbon price signals

The problem: The ETS reforms will not deliver sufficient investment signals

- The EU ETS CO2 price – despite the boost from recent reforms – is insufficient in the short term to drive significant coal gas switching , creates a risk of lock in of fossil plants, and does not provide a strong and credible enough signal for renewables investment in the medium to long term
- The ETS price is volatile with significant downside risk – this raises the cost of capital (WACC) and reduces access to finance
- The impact of the ETS price risk on electricity prices compounds this uncertainty – which could undermine investment at a time when clean technologies are increasingly bearing market risk

A Carbon Price Floor (CPF) would enhance the efficiency of the power sector transition

- CPF acts as an insurance mechanism for investors, protecting them against sudden ETS price drops caused by a significant demand/supply imbalance, and against potential weak macroeconomic conditions leading to oversupply and insufficient abatement*
- Emissions in the CPF countries could be significantly reduced in 2030, and indeed reduced across the EU as whole
- Electricity and emissions leakage through cross-border flows can be minimised by the MSR as well as complementary policy to maintain ETS demand levels, and through ensuring that the CPF zone is of a minimum acceptable size
- Renewables investment would be supported in a world where projects are increasingly exposed to merchant price risk
- A CPF would drive greater coal to gas switching, and provide a clearer investment signal to avoid lock-in of fossil plants
- Power price impacts depend on the interaction of two effects – the CPF would increase power prices to the extent and for as long as fossil fuel plants remain on the system and set market prices. This is counterbalanced by the "merit order effect"- if the CPF encourages higher renewables penetration, this shifts the merit order and lowers market prices
- Impacts on consumers and Energy Intensive Industries (EIIs) may be positive insofar as power prices are lower with a CPF
- If there were additional costs, these can be mitigated using Government revenues raised from the CPF

* The academic literature has for many years discussed the higher efficiency of hybrid price and quantity instruments like a CPF in tandem with the ETS see e.g. Newbery et al (2018), Pizer (2002), Nordhaus (2007)

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